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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

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JUL 1 3 2007

GROUP 1700

Application Number: 10/061,830
Filing Date: January 31, 2002
Appellants: Liu et al.

Craig A. Slavin
For Appellant

SECOND SUPPLEMENTAL EXAMINER'S ANSWER

This is in response to the Appeal Briefs filed August 17, 2005 and October 17, 2005, Reply Briefs filed March 9, 2006 and February 1, 2007 and the Remends to the examiner from BPAI dated October 27, 2006 and May 31, 2007, respectively.

(1) Real party in Interest

A statement identifying the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

A statement identifying the related appeals and interferences which will directly affect or be directly affected by or have a bearing on the decision in the pending appeal is contained in the brief.

(3) Status of Claims

The statement of the status of the claims contained in the brief is correct.

(4) Status of Amendments After Final

The Appellants' statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The Appellant's statement of the grounds of rejection in the brief is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

The following is a listing of the prior art of record relied upon in the rejection of claims under appeal.

Number	Name	Date
US 6,152,382	Pun	November 28, 2000
US 6,440,594 B1	Kindler et al.	August 27, 2002
US 6,572,993 B2	Singh et al.	June 3, 2003

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Specification

1. The amendment filed on January 11, 2005 is objected to under 35 U.S.C. 132 because it introduces new matter into the disclosure. 35 U.S.C. 132 states that no amendment shall introduce new matter into the disclosure of the invention. The added material which is not supported by the original disclosure is as follows: "fuel supply apparatus directs a plurality of droplets into the fuel passage in a direction that is substantially parallel to the anode surface" as recited in claim 83 of the amendment filed January 11, 2005.

Claim Rejections - 35 USC § 112

2. Claim 83 is rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. The limitations "fuel supply apparatus directs a plurality of droplets into the fuel passage in direction that is substantially parallel to the anode surface" in claim 83 are not supported in the specification. If applicant believes said limitations are fully defined, it is requested that applicant indicates column and line, and/or figure with number, in the instant disclosure.

Claim Rejections - 35 USC § 102

3. Claims 1-3,7,8,11-15,17,20,82,84,85,89 are rejected under 35 U.S.C. 102(e) as being anticipated by Kindler et al. (US 6,440,594 B1).

With respect to claims 1,3,11,14,85, Kindler et al. teach a direct oxidation fuel cell system comprising a plurality of anodes, a plurality of cathodes, a plurality of electrolyte and a fuel reservoir. The fuel is provided in the form of an aerosol of liquid fuel droplets suspended in a gas. The aerosol is formed in a single aerosol generator situated within the anode chamber of the fuel cell. Figure 6 is a schematic representation of a preferred fuel cell system incorporating a stack of individual membrane electrode assemblies. The fuel cell is formed by joining a plurality of anode biplates (602) and a plurality of cathode biplates (604), wherein the anode biplate (602) has an internal surface comprising a flowfield element (610) and an atomizer. The anode pair is interpreted as the series of the anode bipolar plates (602) as shown in Figure 6,

wherein fuel is distributed between at least one anode pair along the fuel passage therebetween. Kindler et al. further teach the fuel cell system comprising an aerosol generator (21) (a single fuel supply apparatus), which comprises a plurality of atomizers (25) that form an aerosol of liquid fuel droplets suspended in the anode. Alternatively, the pump (20) or the can be considered as the single fuel supply apparatus. See Abstract; Column 1, Line 64 to Column 2, Line 11; Column 3, Lines 29-34; Column 5, Lines 27-47; Column 15, Line 57 to Column 16, Line 21; Figure 6.

With respect to claim 2,13,17,84, Kindler et al. the amount of aerosol fuel delivered to the anode depends upon the particular oxidation catalyst used in the anode, the permeability of the membrane in the electrode assembly to liquid fuel, the fuel concentration in the aerosol droplets, and the temperature and pressure within the cell. By monitoring fuel cell operating characteristics it is possible to determine an optimum aerosol feed rate for a give fuel cell configuration and cell operating conditions. For example, monitoring fuel cell power output, cell potential, or operating current provides convenient measures of fuel cell operating performance suitable for use in controlling the rate of aerosol fuel delivery to the anode. Preferably, the fuel droplet delivery rate is controlled by varying the duty cycle of the aerosol generator to maintain a desired cell output potential at a given power output. See Column 7, Lines 31-67. Kindler et al. do not specifically disclose the presence of a controller in the fuel cell system. However, it is the position of the examiner that such controller is inherent, given that both Kindler et al. and the present application utilize similar operation procedure and control sequence to operate the direct oxidation fuel cell system. Also, a controller would be essential to monitor and regulate the fuel

droplet delivery rate into the fuel passage. A reference which is silent about a claimed invention's features is inherently anticipatory if the missing feature is necessarily present in that which is described in the reference. *In re Robertson*, 49 USPQ2d 1949 (1999).

With respect to claim 7,12,15,89, Kindler et al. further teach any number of means for forming an aerosol may be employed. For example, an aerosol may be formed by heat the fuel to a temperature above its boiling point in the presence of the suspending gas, then rapidly cooling the superheated fuel vapor to nucleate condensed droplets of liquid fuel suspended in the gas. The aerosol is preferably formed by atomizing the liquid fuel into the suspending gas. A wide variety of atomization means are known to those skilled in the art and may be employed in this invention. These include orifices, single fluid atomization nozzles (airless sprayers), two fluid atomization nozzles (gas-assisted sprayers), rotating discs or wheels onto which the liquid is fed, or ultrasonic nozzles in which liquid is feed onto a needle or orifice oscillated at very high frequency to form liquid droplets in a suspending gas. See Column 7, Lines 14-30.

With respect to claim 8, the recitation "fuel supply means" is understood as a fuel supply apparatus that includes a manifold (146) and a fan (148) in addition to a thermal drop ejector (128). The thermal drop ejector, the manifold and the fan together perform the function of supplying a plurality of droplets to the fuel passage between an anode pair according to the admission by the Appellants in page 3 of the Supplemental Reply Brief filed February 1, 2007.

Kindler reference teaches a direct methanol fuel cell system, wherein the liquid fuel is supplied via a duct (29) (i.e., manifold) to a pump (20), which is provided for circulating the liquid fuel to a aerosol generator (21) (i.e., fuel supply apparatus). The aerosol generator is used

to form an aerosol of liquid fuel droplets into a plurality of anode biplates (602). See Column 5, Lines 40-44, Column 15, Lines 57-67, Figures 1, 4 and 6. Moreover, it is the position of the examiner that the pump is considered to function as a fan, which is used to move or impel the liquid fuel into the aerosol generator as shown in Figure 1 of Kindler.

With respect to claim 11, Kindler further teaches the use of a methanol reservoir to provide the fuel. See Figure 1.

With respect to claim 14, Kindler further teaches the fuel droplets rest on either surfaces of the anode biplate. See Figure 4 and Column 13, Lines 46-65.

With respect to claim 20, the recitation "fuel supply means", as discussed above, is understood as a fuel supply apparatus that includes a manifold (146) and a fan (148) in addition to a thermal drop ejector (128). The thermal drop ejector, the manifold and the fan together perform the function of supplying a plurality of droplets to the fuel passage between an anode pair according to the admission by the Appellants in page 3 of the Supplemental Reply Brief filed February 1, 2007.

Kindler et al. teach a fuel supply system comprising a liquid fuel, i.e., methanol, container. See Figure 1. Kindler reference further teaches the liquid fuel is supplied via a duct (29) (i.e., manifold) to a pump (20), which is provided for circulating the liquid fuel to a aerosol generator (21) (i.e., fuel supply apparatus). The aerosol generator is used to form an aerosol of liquid fuel droplets into a plurality of anode biplates (602). See Column 5, Lines 40-44, Column 15, Lines 57-67, Figures 1, 4 and 6. Moreover, it is the position of the examiner that the pump is

considered to function as a fan, which is used to move or impel the liquid fuel into the aerosol generator as shown in Figure 1 of Kindler.

Kindler et al. further teach the amount of aerosol fuel delivered to the anode depends upon the particular oxidation catalyst used in the anode, the permeability of the membrane in the electrode assembly to liquid fuel, the fuel concentration in the aerosol droplets, and the temperature and pressure within the cell. By monitoring fuel cell operating characteristics it is possible to determine an optimum aerosol feed rate for a give fuel cell configuration and cell operating conditions. For example, monitoring fuel cell power output, cell potential, or operating current provides convenient measures of fuel cell operating performance suitable for use in controlling the rate of aerosol fuel delivery to the anode. Preferably, the fuel droplet delivery rate is controlled by varying the duty cycle of the aerosol generator to maintain a desired cell output potential at a given power output. See Column 7, Lines 31-67. Kindler et al. do not specifically disclose the presence of a controller in the fuel cell system. However, it is the position of the examiner that such controller is inherent, given that both Kindler et al. and the present application utilize similar operation procedure and control sequence to operate the direct oxidation fuel cell system. Also, a controller would be essential to monitor and regulate the fuel droplet delivery rate into the fuel passage. A reference which is silent about a claimed invention's features is inherently anticipatory if the missing feature is necessarily present in that which is described in the reference. *In re Robertson*, 49 USPQ2d 1949 (1999).

With respect to claim 82, Kindler et al. teach the aerosol generator directs a plurality of fuel droplets into the fuel passage in a direction that is non-perpendicular to the anode biplate as evidenced in the disclosures of Figures 4 and 6.

Claim Rejections - 35 USC § 103

4. Claims 4-6,86-88 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kindler et al. (US 6,440,594 B1) as applied to claims 1-3,7,8,11-15,17,20,82,84,85,89 above.

Kindler et al. disclose a fuel cell system comprising an ultrasonic atomizer as the fuel supply apparatus as described above in Paragraph 3. However, Kindler et al. do not specifically disclose the use a thermal drop ejector, a piezoelectric drop ejector, or a flextensional drop ejector to produce the fuel droplets into the fuel passage. Nevertheless, Kindler et al. disclose the amount of fuel delivered to the anode may be manipulated by adjusting the atomization conditions; for example, liquid feed rate, nozzle pressure, rotational speed of the disk, or oscillation frequency or power for an ultrasonic nozzle. Such methods are well known to those skilled in the art. Alternatively, the atomizer may be operated in a discontinuous manner, for example, by pulsing the liquid feed to the atomizer or pulsing the delivery of liquid fuel droplets from the atomizer. For example, the atomizing gas (for a two fluid atomization nozzle), rotational means (for a rotary nozzle) or oscillation means (for an ultrasonic nozzle) may be turned on or off alternately in a pulsed manner in order to maintain the desired fuel droplet delivery rate as reflected by the measured cell output potential and power output. Moreover, each in situ atomizer 612 may be selected from a wide variety of atomization means, including

orifices, single fluid atomization nozzles (airless sprayers), two fluid atomization nozzles (gas-assisted sprayers), rotating discs or wheels onto which the liquid is fed, or ultrasonic nozzles in which liquid is feed onto a needle or orifice oscillated at very high frequency (typically ≥ 20 kHz) to form liquid droplets in a suspending gas. See Column 7, Lines 14-61; Column 15, Line 66 to Column 16, Line 10. Kindler reference teaches the delivery of droplet fuel using various means is well known to those skilled in the art. Therefore, it would have been obvious to one of ordinary skill in the art to substitute a thermal drop ejector (or a piezoelectric drop ejector, or a flextensional drop ejector) for the ultrasonic atomizer as the fuel droplet generating means in the fuel cell system disclosed by Kindler, because they are considered functionally equivalent fuel delivering means.

5. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kindler et al. (US 6,440,594 B1) as applied to claims 1-3,7,8,11-15,17,20,82,84,85,89 above, and further in view of Singh et al. (US 6,572,993 B2).

The recitation "storage means for storing energy" in claim 9 is understood as an energy storage device such as a battery or capacitor. See Page 7, Lines 24-26 of the instant specification. The interpretation of the "storage means" limitation is concurred by the Appellants (see page 4 of the Supplemental Reply Brief filed February 1, 2007).

Kindler et al. disclose a fuel cell system as described above in Paragraph 3. However, Kindler et al. do not disclose that the fuel cell system further comprising a storage means for storing energy generated by the system.

Singh et al. teach an electrical storage device is coupled in parallel to a fuel cell power generation system. The electrical storage device is either a battery pack, a plurality of capacitors, or a plurality of supercapacitors. The electrical storage device is capable of minimizing the unreacted fuel within the anode chamber. See Abstract, Column 1, Lines 40-64; Column 2, Lines 3-29. Therefore, it would have been obvious to one of ordinary skill in the art to coupled an electrical storage device to the fuel cell system of Kindler et al. in parallel, because Singh et al. teach the use of either a battery pack, capacitors or supercapacitors to reduce the amount of excess fuel during transient operating conditions.

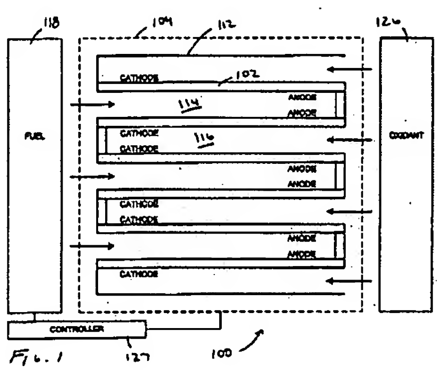
6. Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kindler et al. (US 6,440,594 B1) as applied to claims 1-3,7,8,11-15,17,20,82,84,85,89 above, and further in view of Pun (US 6,152,382).

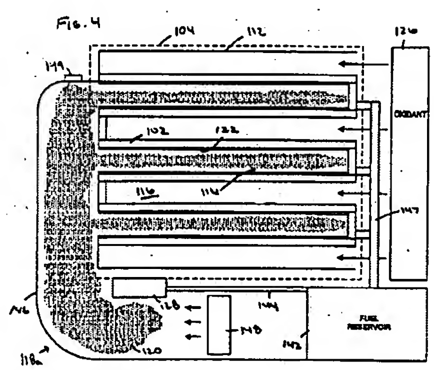
Kindler et al. disclose a method of operating a fuel cell as described above in Paragraph 3. However, Kindler et al. do not disclose the use of a fan in blowing the droplets towards the anode. Pun teaches that fans and blowers are required to project the atomized droplets to intended targets. See Column 1, Lines 22-25. Therefore, it would have been obvious to one of ordinary skill in the art to incorporate a fan on the method of operating a fuel cell of Kindler et al., because Pun teaches the use of a fan to help project the atomized droplets to the intended targets (anode plates) in the fuel cell system.

(10) Response to Argument

1. The invention defined by claim 83 is clearly supported by the application as filed. The arrows in Figure 1 clearly indicate the fuel is directed into the fuel passages 114 in a direction that is substantially parallel to the surfaces of the anodes that receive fuel.

Figure 1 in the instant specification shows a diagrammatic view of a fuel cell system in which fuel is supplied to the fuel passages 114 and oxygen or air is supplied to the oxidant passages 116. The arrows, which are not described nor discussed in the disclosure, appear to indicate the general directions of movement for the fuel and oxidant, respectively. These arrows are only used to help illustrate the supply of fuel droplets into the anode plates 114 and the flow of oxygen into the cathode plates 116. They do not provide any support or indication with respect to the travel direction of the fuel droplet.





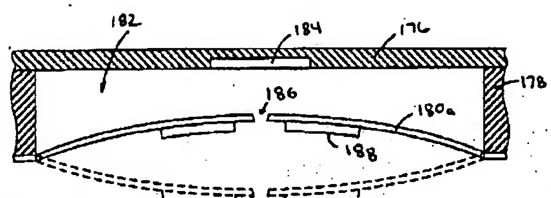


Fig. 16

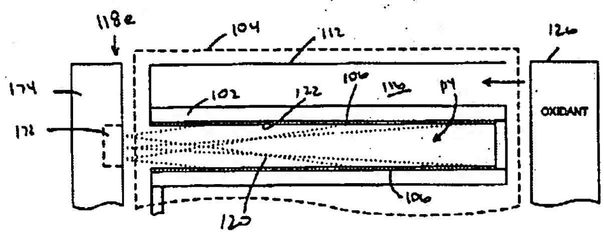


Fig. 18

This conclusion is further illustrated by the disclosure in Figures 4 (see above),7,8,9,13,18,19 of the instant specification in which the travel trajectory and distribution of the fuel droplets are indicated. Assuming the black dots in the fuel passage are representatives of the fuel droplets, it is evident that the widths of the dotted area vary irregularly and randomly into the anode passage. This is clearly contradictory to the Appellants' assertion that the travel direction of the droplet is parallel to the surface of the anode surface.

Appellants further argue that Figures 16 and 18 of the disclosure provide additional support for the recitation in claim 83. These figures show diagrammatic views of a fuel cell system that uses a flextensional drop ejector to supply the fuel droplets. As shown in Figure 18 above, the dotted lines not only intercept the anode surface at various locations along the fuel passage but also cross each other even when the lines of fire point at the same general direction (i.e., upward or downward). One of ordinary skill in the art would not recognize that the fuel droplets travel substantially parallel to the anode surface that receives fuel. The limitations "fuel supply apparatus directs a plurality of droplets into the fuel passage in direction that is

substantially parallel to the anode surface" in claim 83 is deemed as a new matter that is not disclosed nor supported, inherently or explicitly, in the instant specification.

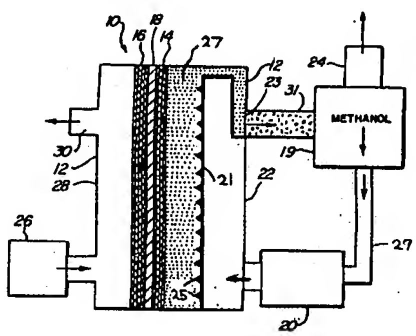
Appellants further alleges in page 8 of the Supplemental Reply Brief dated February 1, 2007 that the first firing mode, which is illustrated in Figure 16 (see above), show fuel droplets ejected by the drop ejectors travel in direction that is generally perpendicular to the plate defined by the outermost portion of the nozzle. However, the instant specification does not provide any discussion whatsoever regarding the relationship between anode surface and the travel direction of the droplets. Droplets fired straight out of the drop ejector nozzles can travel with trajectories as shown in Figure 18 above. It is the position of the examiner that one of skill in the art would not recognize that droplets filed straight out of the drop ejector nozzles (186) would travel in a direction that is substantially parallel to the surface of the anode.

2. Independent claim 1 calls for a combination of elements comprising a fuel cell stack including a plurality of anodes, and a single fuel supply apparatus that supplies a plurality of fuel droplets to each of the anodes, which Kindler fails to teach.

Kindler et al. teach a preferred aerosol feed fuel cell configuration in which membrane electrode assemblies are stacked to obtain uniform fuel delivery as shown in Figure 6. The fuel cell 600 (fuel cell stack) is formed by joining a plurality of anode biplates (602) and a plurality of cathode biplates (604). Figure 6 further disclose the use of an aerosol generator (21 in Figure 1 as the single fuel supply apparatus) comprising a plurality of individual in-situ atomizers 612 (25 in Figure 1), each atomizer situated at the internal surface of the anode biplate 602 so as to

atomize liquid fuel droplets into the anode chamber 616. See Column 5, Lines 38-41; Column 15, Line 57 to Column 16, Line 2. As the Kindler patent teach each and every element of the combination recited in independent claim 1, the rejection of claims 1-3 and 7 under 35 U.S.C. § 102 should be sustained.

FIG. 1



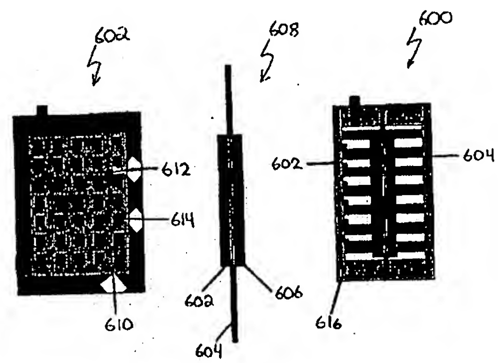


Fig. 6

Appellants further allege in page 10 of the Supplemental Reply Brief dated February 1, 2007 that the Kindler specifically indicated each anode has an aerosol generator and each aerosol generator has a plurality of atomizers. It appears that Appellants purposely misrepresent the teaching of Kindler reference, which contradicts with their arguments. The passage quoted by the Appellants is duplicated as follows (Kindler, Column 15, Line 63 to Column 16, Line 2).

> FIG 6. illustrates a preferred aerosol generator comprising a plurality of individual in situ atomizers, each atomizer 612 situated at the internal surface of the anode biplate 602 so as to atomize liquid fuel droplets into the anode chamber 618 (emphasis added).

As discussed above, Kindler never discloses the use of multiple aerosol generators in the system. On the contrary, Kindler repeatedly teaches the use of a single aerosol generator for the entire fuel cell system, e.g., component 21 in Figure 1 (see above) and component 321 in Figure3 (see below). Unequivocally, Kindler references disclose a fuel cell stack including a plurality of

anodes and a single fuel supply apparatus, i.e., the aerosol generator, that supplies a plurality of fuel droplets to each of the anode (anode biplate 602) as recited in claim 1 of the present invention.

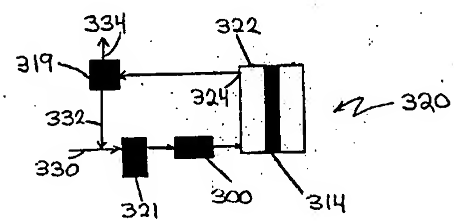


Figure 3

3. *Independent claims 8 and 11 calls for a combination of elements comprising a fuel cell stack including at least one anode pair arranged such anodes within the anode pair face one another and define a fuel passage therebetween that extends from one anode in the pair to the other anode in the pair, which Kindler fails to teach.*

Kindler et al. teach the fuel cell (600) (fuel cell stack) is formed by joining a plurality of anode biplates (602) and a plurality of cathode biplates (604). See Column 15, Lines 57-65. It would be recognized by one of ordinary skill in the art that the anode biplate in Figure 6 above is defined as two parallel plates facing each other to define a fuel passage (chamber) therebetween. Figure 6 illustrate an aerosol generator made up of a plurality of nozzles. Each nozzle is an atomizer (612) and is situated at the internal surface of the anode biplate (602) so as to atomize liquid fuel droplets into the anode chamber (616) (fuel passage). See Column 15, Line 66 to Column 16, Line 21. Kindler et al. further teach the use of a methanol reservoir in the fuel cell system. See Figure 1 above. As the Kindler patent teach each and every element of the

combination recited in independent claims 8 and 11, the rejection of claims 8 and 11-13 under 35 U.S.C. § 102 should be sustained.

Appellants further dispute in the Supplemental Reply Brief dated February 1, 2007 (pages 11 and 12) that the phrase "anode biplate" in the Kindler patent is a typographic error because its definition is unconventional and confusing to the Appellants. Again, Kindler reference discusses the fuel cell (600) is formed by joining an anode biplate (602) and a cathode biplate (604) as shown above. The membrane electrode assembly (608) is formed by joining an anode assembly (biplate) and cathode assembly (604) to opposite surfaces of the interposed membrane. Kindler further teaches schematic representation of an aerosol fuel feel being transported in the anode biplate. Figure 4 below shows the case of low power density operation, in which liquid droplets (432) travel between two opposing porous anode backing materials (436) to the catalyst layer (438). Similarly, liquid droplets (532) travel between two opposing anode backing materials (536) are shown in Figure 5, in which higher rate of droplet coalescence occurs before the fuel droplets reach the catalyst layer (538). See Column 13, Line 46 to Column 14, Line 29.

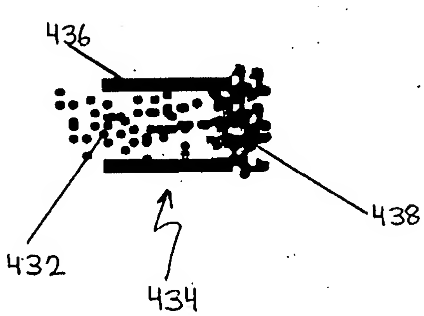


Fig. 4

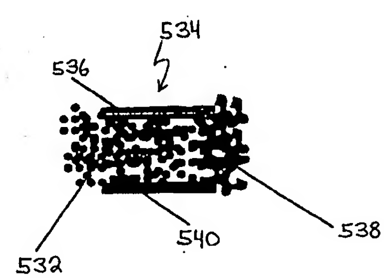


Fig. 5

It can be drawn from the disclosure above that the term "anode assembly" and "anode biplate" are interchangeable because both terms define an anode chamber in which fuel droplets pass through before they reach the catalyst surface. The "anode biplate" in the Kindler reference therefore can be labelled as "anode pair" as recited in claims 8 and 11 because both have anodes that face one another with a fuel passage therebetween.

4. *Independent claim 14 calls for a method including the step of directing a spray of fuel droplets into a fuel passage that extends from a first anode in an anode pair to a second anode in the anode pair, which Kindler fails to teach.*

Kindler et al. teach a method to operate a fuel cell 600 (fuel cell stack) which is formed by joining a plurality of anode biplates (602) and a plurality of cathode biplates (604). See Column 15, Lines 57-65. It would be recognized by one of ordinary skill in that art that the anode biplate in Figure 6 above is defined as two parallel anodes facing each other to define a fuel passage between the two anode surfaces. Atomizer is situated at the internal surface of the anode biplate (602) so as to atomize liquid fuel droplets into the anode chamber 616 (fuel passage).

Furthermore, the fuel droplets (432) would necessarily come to rest one both the first anode surface and the second anode surface (436) as shown in Figures 4 and 5 above. See Column 13, Lines 46-56. As the Kindler patent teach each and every element of the combination recited in independent claim 14, the rejection of claims 14,15 and 17 under 35 U.S.C. § 102 should be sustained.

Appellants further dispute in the Supplemental Reply Brief dated February 1, 2007 (page 13) that the Figures 4 and 5 of Kindler merely show fuel droplets entering an individual pore in a single porous anode. As discussed in details above, the anode biplate is defined by <u>two</u> opposing porous anodes (436 in Figure 4 and 536 in Figure 5) with a fuel passage therebetween. Figures 4 and 5 of Kindler visibly show some of the droplets come to rest on first anode surface and some the droplets come to rest on second anode surface.

5. Independent claim 20 calls for a combination of elements including a controller adapted to monitor a rate of fuel consumption a the anode and to controller the fuel supply means to supply droplets at a rate that results in a fuel layer being maintained on the anode, which Kindler fails to teach.

Kindler patent teaches it is possible to determine an optimum aerosol feed rate for a given fuel cell configuration and cell operating conditions by monitoring fuel cell operating characteristics. Also, the amount of fuel delivered to the anode may be manipulated by adjusting the atomization conditions, for example, liquid feed rate, nozzle pressure, rotational speed of the disk or oscillation frequency. See Column 7, Lines 39-51. Kindler patent further teaches that it is preferable to prevent the anode, anode catalyst pores and any anode support or backing material, from becoming saturated (flooded) with liquid fuel. See Column 8, Lines 19-29. The reference suggests the formation of a <u>discrete</u> layer of fuel layer upon the determination of the optimum fuel feel rate by the fuel controller. As the Kindler patent teach each and every element

of the combination recited in independent claim 20, the rejection of the claim under 35 U.S.C. § 102 should be sustained.

6. *Independent claim 82 calls for a combination of elements including a fuel supply apparatus that directs a plurality of fuel droplets into the fuel passage in a direction that is non-perpendicular to the anode surface, which Kindler fails to teach.*

Kindler patent teaches a fuel cell that introduces the fuel as an aerosol of liquid fuel droplets suspended in a gas. It is understood by those skilled in the art that a preferred droplet size or size distribution may exist for any particular fuel cell configuration or operating mode. In particular, aerosol droplets that are small may under go Brownian motion, wherein droplets that are large may coalesce to form even larger droplets. See abstract, Column 8, Lines 5-18. As shown in Figures 4 and 5 above, the distribution of the liquid fuel droplets in the anode biplate is random and non-uniform such that their travel directions have to be non-perpendicular to the anode surface that receives fuel. As the Kindler patent teach each and every element of the combination recited in independent claim 82, the rejection of claims 82,84,85 and 89 under 35 U.S.C. § 102 should be sustained.

7. *Independent claims 4,5,6 call for a fuel cell comprising a thermal drop ejector, a piezoelectric drop ejector and a flextensional drop ejector respectively, which Kindler fails to teach or suggest.*

Kindler et al. disclose any number of means for forming an aerosol may be employed. For example, an aerosol may be formed by heat the fuel to a temperature above its boiling point in the presence of the suspending gas, then rapidly cooling the superheated fuel vapor to nucleate condensed droplets of liquid fuel suspended in the gas (functional and mechanical equivalent of the claimed thermal drop ejector). See Column 7, Lines 14-20. Kindler et al. further teach a wide variety of atomization means are known to those skilled in the art and may be employed in this invention. These include orifices, single fluid atomization nozzles (airless sprayers), two fluid atomization nozzles (gas-assisted sprayers), rotating discs or wheels onto which the liquid is fed, or ultrasonic nozzles in which liquid is feed onto a needle or orifice oscillated at very high frequency (typically $\geq$ 20 kHz) (functional and mechanical equivalent of the claimed piezoelectric drop ejector) to form liquid droplets in a suspending gas. See Column 7, Lines 21-29. Kindler et al. further teach the atomizer may be operated in a discontinuous manner, for example, by pulsing the liquid feed to the atomizer or pulsing the delivery of liquid fuel droplets from the atomizer. For example, the atomizing gas (for a two fluid atomization nozzle), rotational means (for a rotary nozzle) or oscillation means (for an ultrasonic nozzle) (functional and mechanical equivalent of the claimed flextensional drop ejector) may be turned on or off alternately in a pulsed manner in order to maintain the desired fuel droplet delivery rate as reflected by the measured cell output potential and power output. See Column 7, Lines 52-60. Therefore, it would have been obvious to one of ordinary skill in the art to substitute a thermal drop ejector (or a piezoelectric drop ejector, or a flextensional drop ejector) for the ultrasonic atomizer as the fuel droplet generating means in the fuel cell system disclosed by Kindler,

because they are considered functionally equivalent fuel delivering means. As the Kindler patent meet a *prima facia* case of obviousness with respect to claims 4-6, the rejection of these claims under 35 U.S.C. § 103 should be sustained.

Appellants further dispute in the Supplemental Reply Brief dated February 1, 2007 (page 16) that examiner fails to provide any concrete evidence that shows the alleged equivalency. First, it has come to realize that the different ejectors recited in claims 4 through 6 are not widely recognized in the patent literature, let alone in the fuel cell art. Using the USPTO search tool EAST, the term "flextensional drop ejector" only appears once when all the database, including PGPUB, USPAT, EPO, JPO and DERWENT, are searched. Not surprisingly, the term is only cited in the instant specification. The term "thermal drop ejector" is found in two patent literatures while "piezoelectric drop ejector" is found in eight. Examiner does not believe that issued patents, published applications or journal articles would be required to show the proposed equivalency. Nevertheless, the functional and mechanical equivalency between the ejectors disclosed by Kindler and the present disclosure is established based on the limited description and technical information available in the instant disclosure. As discussed above, rationale and reasoning to substitute equivalents known for the same purpose are carefully presented. The court upheld an express suggestion to substitute one equivalent component or process for another is not necessary to render such substitution obvious. *In re Fout*, 675 F.2d 297, 213 USPQ 532 (CCPA 1982).

8. *Regarding independent claim 16, Office Action fails to identify a common problem that one of skill in the art would associate with both the generation of electricity with fuel cells and the teaching of Pun patent.*

Pun reference teaches an apparatus and method for controlled droplet atomization and controlled projection of atomization droplets. The apparatus generates laminar airflow in a vortex or cyclone pattern functioning to project and distribute spray droplets evenly and more completely on the sprayed surfaces. In particular, Pun teaches the use of fans and blowers to project the atomized droplets to intended targets. See Abstract; Column 1, Lines 22-25. Pun further discloses it should be appreciated that the present invention can produce different sized atomized droplets and control the projection and direction of those droplets accordingly for spraying on a spray surface. For example, a 50-micron diameter droplet is preferred for agricultural spraying. Fog size droplets could be suitable for greenhouse application purposes. Other droplet sizes could be suitable for the different applications described above. See Column 7, Lines 26-32. Clearly, the Pun reference is related to the control of droplet size and droplet trajectory in atomization-related applications, which is also the focal point of Kindler reference. A prior art reference is analogous if the reference is in the field of applicant's endeavor or, if not, the reference is reasonably pertinent to the particular problem with which the inventor was concerned. *In re Oetiker*, 977 F.2d 1443, 1446, 24 USPQ2d 1443, 1445 (Fed. Cir. 1992). See MPEP 2145. As the Kindler and Pun references meet a *prima facia* case of obviousness with respect to claim 16, the rejection of the claim under 35 U.S.C. § 103 should be sustained.

9. *Regarding dependent claims 86-88, Office Action fails to provide an evidence or in any other context that "thermal", "piezoelectric" and "flextensional" drop ejectors are functional equivalent to an ultrasonic atomizer.*

Again, Kindler et al. disclose an aerosol may be formed by heat the fuel to a temperature above its boiling point in the presence of the suspending gas, then rapidly cooling the superheated fuel vapor to nucleate condensed droplets of liquid fuel suspended in the gas. See Column 7, Lines 14-20. This apparatus is considered to be functional and mechanical equivalent of the claimed thermal drop ejector. Kindler et al. further teach a wide variety of atomization means are known to those skilled in the art and may be employed in this invention. These include orifices, single fluid atomization nozzles (airless sprayers), two fluid atomization nozzles (gas-assisted sprayers), rotating discs or wheels onto which the liquid is fed, or ultrasonic nozzles in which liquid is feed onto a needle or orifice oscillated at very high frequency (typically ≥ 20 kHz) to form liquid droplets in a suspending gas. See Column 7, Lines 21-29. Piezoelectric material is known for use in the generation of vibration frequency. This apparatus is, therefore, considered to be functional and mechanical equivalent of the claimed piezoelectric drop ejector. Kindler et al. further teach the atomizer may be operated in a discontinuous manner, for example, by pulsing the liquid feed to the atomizer or pulsing the delivery of liquid fuel droplets from the atomizer. For example, the atomizing gas (for a two fluid atomization nozzle), rotational means (for a rotary nozzle) or oscillation means (for an ultrasonic nozzle) may be turned on or off alternately in a pulsed manner in order to maintain the desired fuel droplet delivery rate as reflected by the measured cell output potential and power output. See Column 7, Lines 52-60.

The rotational and oscillation functions of the atomizer are considered to be equivalent to that of the claimed flextensional drop ejector. Therefore, it would have been obvious to one of ordinary skill in the art to substitute a thermal drop ejector (or a piezoelectric drop ejector, or a flextensional drop ejector) for the ultrasonic atomizer as the fuel droplet generating means in the fuel cell system disclosed by Kindler, because they are considered functionally equivalent fuel delivering means. As the Kindler patent meet a *prima facia* case of obviousness with respect to claims 86-88, the rejection of these claims under 35 U.S.C. § 103 should be sustained.

Appellants further dispute in the Supplemental Reply Brief dated February 1, 2007 (page 17) that the mere fact that two components are functionally and mechanically equivalent is not, in and of itself, sufficient to establish a *prima facia* case of obviousness. In fact, the instant specification discloses the following findings

> Another type of fuel drop ejector that may form part of an implementation of a present inventions is a piezoelectric fuel drop ejector and <u>piezoelectric drop ejectors may be used in place of thermal drop ejector(s) in any of the embodiments illustrated in FIGS. 4-8</u>. (emphasis added) (page 8 of instant disclosure)
>
> Turning to FIGS. 13-15, a fuel cell system (such as the fuel cell system 100 illustrated in FIG. 1) may be provided with a fuel supply apparatus 118e that produces droplets with a flextensional drop ejector and <u>flextensional drop ejectors may be used in place of thermal drop ejector(s) in any of the embodiments illustrated in FIGS. 4-8</u>. (emphasis added) (page 9 of instant disclosure)

As admitted by the Appellants above, thermal drop ejector, piezoelectric drop ejector and flextensional drop ejector are deemed as functional and mechanical equivalencies because they are used interchangeably to produce and discharge fuel droplets into the fuel passage. The court has upheld that an applicant's expressed recognition of an art-recognized or obvious equivalent

may be used to refute an argument that such equivalency does not exist. *In re Scott*, 323 F.2d 1016, 139 USPQ 297 (CCPA 1963).

For the above reasons, it is believed that all the rejections should be sustained.

Respectfully Submitted,

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